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September 21, 2001

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SEP 21 2001

FEDERAL COMMUNICATIONS COMMISSION  
OFFICE OF THE SECRETARY

David E. Hilliard  
202.719.7058  
dhilliard@wrf.com

Ms. Magalie Roman-Salas  
Secretary  
Federal Communications Commission  
445 12th Street, S.W.  
Washington, DC 20554

Re: ***Ex Parte* Notification - ET Docket No. 98-153 / Ultra Wideband Proceeding**

Dear Ms. Salas:

This is to note that on September 20, 2001, Mimi W. Dawson of this firm along with Ralph Petroff, President of Time Domain, and Jeffrey Ross, Time Domain's Vice-President for Development met with Commissioner Kevin Martin and his Legal Advisor Monica Desai, to discuss the ultra-wideband proceeding. They explained Time Domain's views as set forth in its prior filings that the NPRM's proposed limits are more than adequate for the protection of licensed radio services and urged the Commission to move forward with a decision in this proceeding. In connection with the matter of possible defense applications of UWB technology, Mr. Petroff showed the enclosed slides from a recent conference and provided the enclosed list of projects. He also provided copies of material previously filed with the Commission by Time Domain in this proceeding.

In accordance with the Commission's Rules, an original and one copy of this letter are being filed.

Respectfully,

David E. Hilliard  
Counsel for Time Domain Corporation

No. of Copies rec'd OTL  
List ABCDE

cc: The Honorable Kevin Martin (w/encl.)  
Monica Desai, Esq. (w/ encl.)

Enclosure

# **GOVERNMENT AND DEFENSE PROJECTS**

## **TIME DOMAIN GOVERNMENT PROJECTS**

### **National Institute of Standards and Technology Advanced Technology Program**

- Internal communications and tracking system for medical equipment

### **NASA Johnson Space Center**

- Astronaut / Space Station Extra Vehicular Activity communications and position location and tracking for space walks: Phase II Small Business Innovation Research contract
- 

### **National Science Foundation**

- Universal Home Networking: Phase I Small Business Innovation Research contract

### **Department of Commerce**

- Firefighter locator: Phase I Small Business Innovation Research contract

### **NASA Glenn Research Center**

- Phased Array and SAR Radar: Phase I Small Business Innovation Research contract

### **NASA Goddard Space Flight Center**

- Interspacecraft Communication: Phase I Small Business Innovative Research contract

### **NASA Marshall Space Flight Center**

- Terahertz waveform Cooperative Research and Development Agreement (CRADA)

## **TIME DOMAIN DEFENSE PROJECTS**

### **DoD Military Operations in Urban Terrain Advanced Concept Technology Demonstration**

- Through wall radar for military operations in urban terrain to clear buildings by detecting human presence through walls

### **Office of Naval Research**

- Location and status tracking system for environmental conditions history and shelf life of ammunition in storage depots to circumvent the need for destructive testing and lot sampling

### **Office of the Assistant Secretary of the Navy for Safety and Survivability**

- Personal, Position, Location, and Tracking System to locate sailors aboard ships during life-threatening situations

### **Army Missile and Aviation Command Advanced Concept Office**

- Over-the-horizon communications link using unmanned aerial vehicles: Phase II Small Business Innovation Research contract

### **Army Missile and Aviation Command Weapons Sciences Directorate**

- Blue Laser research: Phase II Small Business Technical Transfer Research contract

### **Army Tank Automotive and Armaments Command Tank Automotive RDE Center**

- Terrain mapping radar system to provide ground truthing for Grizzly mine-breaching program: Phase II Small Business Innovation Research contract

#### **Army Simulation Training and Instrumentation Command**

- Advanced Tactical Engagement Simulation Program for the Objective Infantry Combat Weapon to detect hits on non line-of-sight targets during military exercises: Phase II Small Business Innovation Research contract

#### **Army Simulation Training and Instrumentation Command**

- Cooperative Research and Development Agreement to introduce time modulated ultra wideband technology into military training

#### **National Security Agency**

- Technology license for Army Research Laboratory to study how and where time modulated ultra wideband communications should be implemented for the Army

#### **Marine Corps**

- Personnel Identification System: Phase I Small Business Innovative contract

#### **Defense Threat Reduction Agency**

- Evaluation of UWB for airborne surveillance and ground penetrating radar

#### **Land Warrior Program**

- Evaluation of UWB for Land Warrior Program

#### **Army STRICOM**

- Development of Mobile ad hoc networking BAA with military and commercial dual-use capability

#### **Army STRICOM**

- Aim-point determination and geometric pairing solution for OICW weapon system: Phase II Small Business Innovative Research contract

#### **DoD Office of Science and Technology**

- OST IDIQ Program

#### **Navy Sea Systems Command (NAVSEA)**

- UWB engineering expertise for technology insertion into Naval Applications

#### **Navy Research Lab (NRL)**

- To provide precise timing via wireless

### **COMPLETED PROJECTS**

#### **Defense Advanced Research Projects Agency Advanced Technology Office**

- Self-Healing Minefield program that causes mines to autonomously fill in minefield breaches

#### **Army Corps of Engineers**

- Cooperative Research and Development Agreement to mark locations of unexploded ordnance on training ranges, for subsequent munitions clearing

#### **Army Space and Missile Defense Command Battle Lab**

- Wireless communications for Future Operations Center local area network, the next generation tactical operations center

#### **Army Simulation Training and Instrumentation Command**

- Lightweight Personnel Detection Device to track soldiers during military training exercises

#### **L3 Communications**

- Provision of 3 full duplex evaluation PulsON radios with propagation software.

#### **Navy Training Command**

- Demonstration of Time Domain's PulsON® radio to track weapons on a training range: Phase 1 Small Business Innovation Research contract

#### **Army Material Command**

- Proposal to support intelligent mines with PulsON® radar sensor and PLT

#### **National Telecommunication & Information Agency**

- Utilization of the PulsON® pulsers to facilitate interference testing in support of the FCC NPRM

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#### **Johnson Space Center**

- Astronaut / Space Station Extra Vehicular Activity communications and position location and tracking for space walks: Phase I Small Business Innovation Research contract

#### **Army Missile and Aviation Command Advanced Concept Office**

- Over-the-horizon communications link using unmanned aerial vehicles: Phase I Small Business Innovation Research contract

#### **Air Force Rome Labs**

- UWB SAR Research: Phase I Small Business Innovation Research contract

#### **Army Missile and Aviation Command Weapons Sciences Directorate**

- Photonics Research Support: Phase I Small Business Innovation Research contract

#### **Army Missile and Aviation Command Advanced Concept Office**

- Over-the-horizon communications link using unmanned aerial vehicles: Phase I Small Business Innovation Research contract

#### **Army Tank Automotive and Armaments Command Tank Automotive RDE Center**

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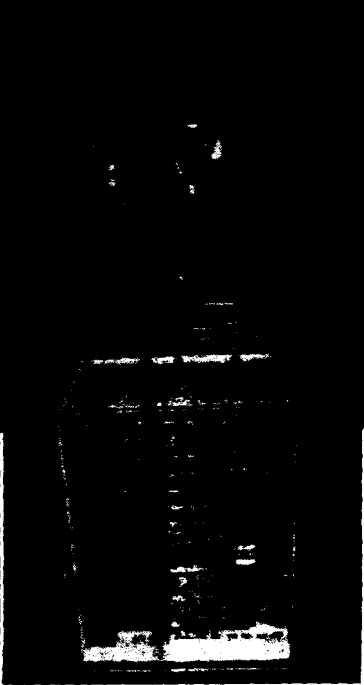
# **Ultra Wide Band Applications and Requirements**

**DARPA NETEX Industry Day  
McLean, VA**

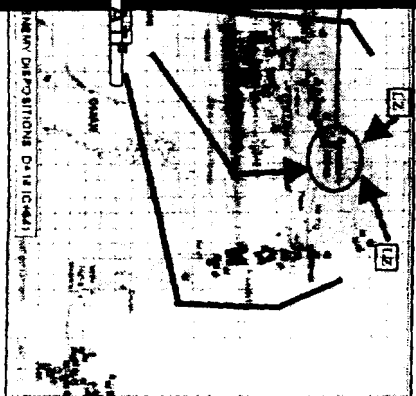
**10 Sept 2001**

**Steven J. Gunderson  
NFESC Port Hueneme**

**V (805) 982-1262, Fax (805) 982-4970  
steve@nfesc.navy.mil**



NEP  
Obj



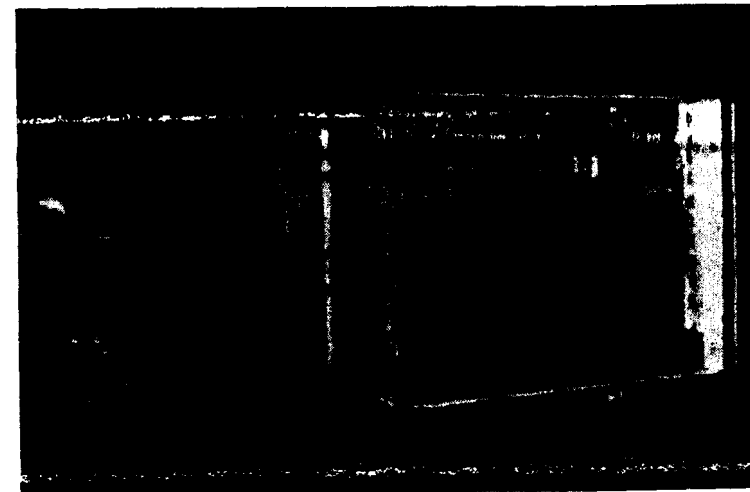
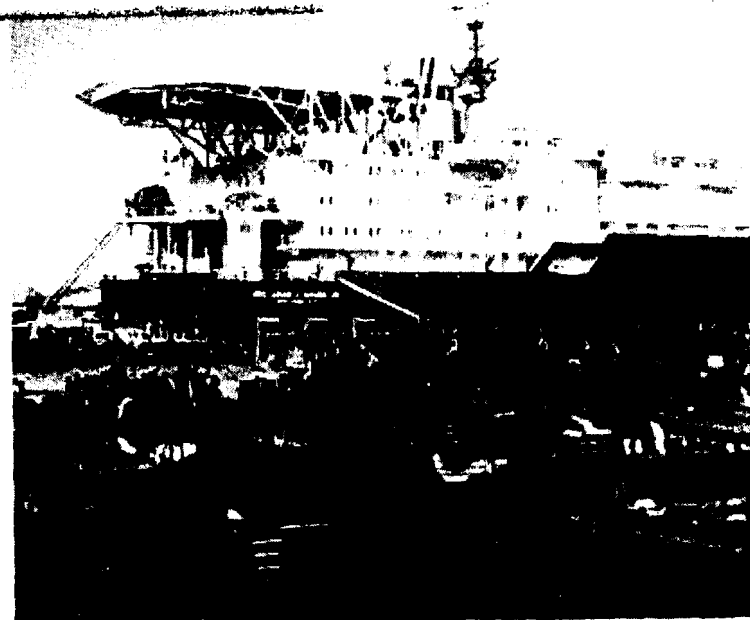
NAVY DISPOSITIONS D-18 (1944) 1000000

# UWB Applications: Logistics

**DARPA**

## Desert Storm

- **First MRC with ISO Containers**
  - 40,000 Containers, Opened 25,000
    - » Paper Manifests Were Inaccurate and Easily Lost
  - ISO Containers Hid the Stuff
    - » Previous MRCs Used Break Bulk
  - Misplaced & Lost Stuff = \$3 Billion
    - » GAO Report B-246015, Dec 1991
- **The BIG Questions**
  - What Do I Have?
  - Where Is My Stuff?
  - What Is In the Box?
  - What Is Its Condition/History?



# UWB Applications: Logistics

DARPA

## Naval Total Asset Visibility (NTAV)

### • Tackle the Unsolved Hard Problems

- Precision Asset Location (PAL)
  - » Where's my Stuff?
  - » Ship Stow Plans
    - 40% Stow Error, Re-Inventory Required
- Autonomous Manifesting (AM)
  - » What's in the Box?
  - » The "Holy Grail of Logistics"
- Infrastructure Reduction (IR)
  - » Cost Reduction (\$K's/Reader)
  - » Ship Pre-Installation and Cabling

### • Transportation is a \$1T Industry

- DoD is Largest Purchaser of Transportation
- US CINC Transportation (TRANSCOM)

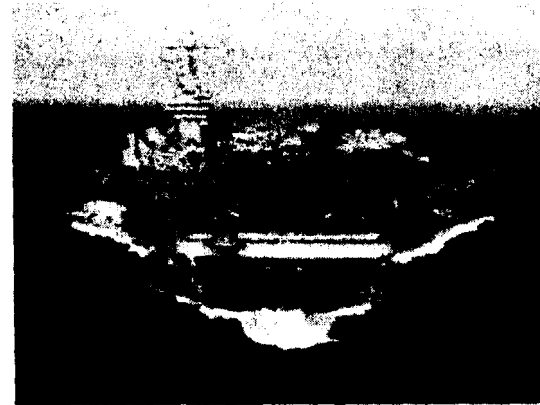




# UWB Applications: Weapons

## Carrier Weapons Management

- **NAVAIR / NAWC Lakehurst**
- **Problem**
  - Aircraft Leave With Partial Loads
    - » Desert Storm: Several Carriers Continuously Launched Aircraft with 2 or Less Weapons
  - Locate Weapon Components for Assembly
    - » Up to 9 hrs for Assembly: 8 Decks, 32 Mags
  - Locate Weapons in Hanger & Flight Decks
    - » Staging Areas, Main Deck, Bomb Farm
- **Hot RF Spots Throughout Carrier**
  - High Powered Radars: EMI / EMC / HERO
- **Proposed Solution**
  - UWB Precision Location of Weapon Sleds: 1 ft
- **Makes Aircraft Carriers More Lethal**



# UWB Applications: Geolocation

DARPA

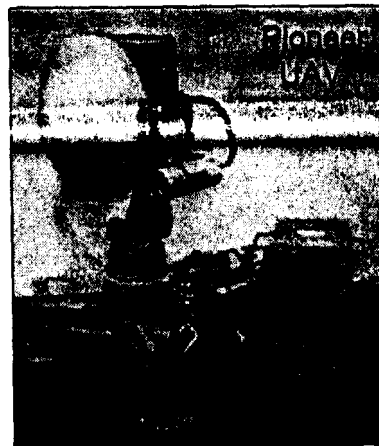
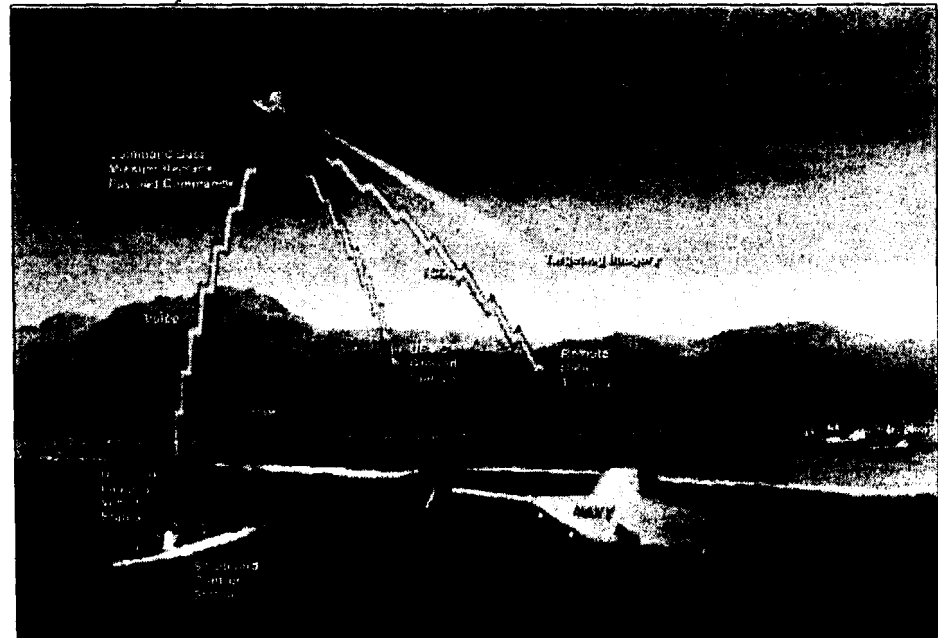
## UAV Landing System

### • UAV Common Automatic Recovery System (UCARS)

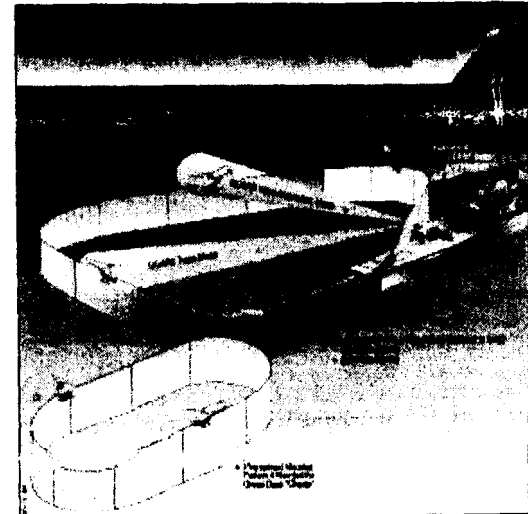
- Pioneer UAV
- Microwave: 3 ft Accuracy
- 6 ft Landing Grid
  - » Pitch / Roll / Stability
  - » Ship Under Way

### • RQ-8 Vertical Takeoff UAV

- 3 hrs 150 nmi, 12 hrs Total
- Payload Capacity = 300 lbs
- Comms Payloads
  - » (3) ARC-210 (Aircraft Radio)
  - » TCDL: 14-15 GHz, 10 Mbps
  - » SINCGARS to Ground MEUs



UCARS Ldg. Sys.





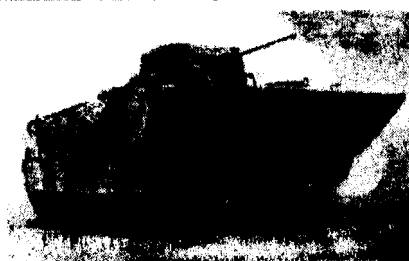
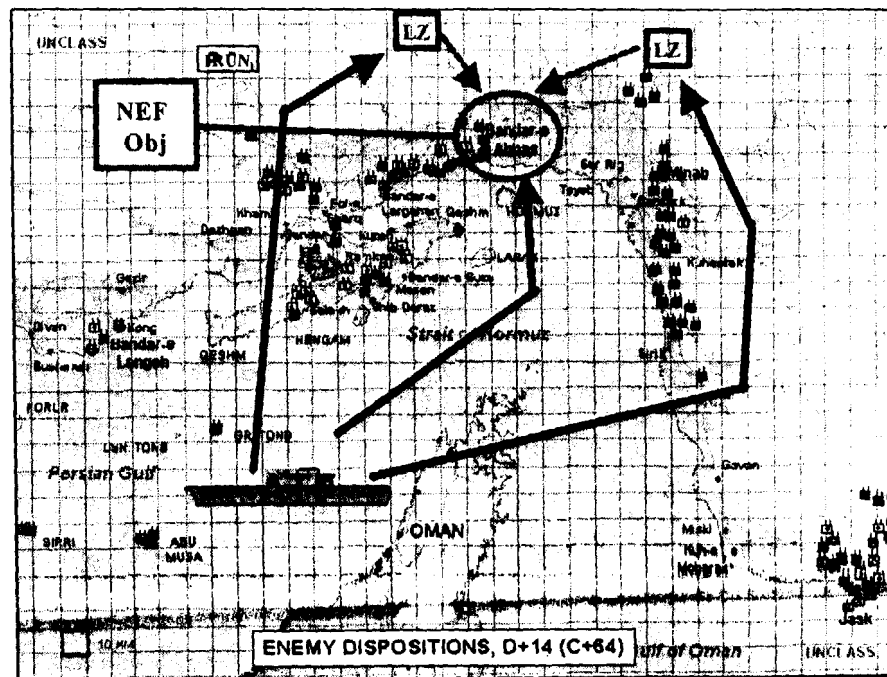
**Concept:**  
Multiple Fleet/Ship Deployed  
High-Altitude Long-Endurance  
Station-Keeping UAV/Airships  
with Lightweight UWB LMR  
Relays Provide OTH Comms  
to Dismounted Warfighters

# UWB Applications: Comms

DARPA

## Marine Corps OMFTS/STOM

- **High Capacity LOS Comms**
  - Replace MRC-142
    - » 576 Kb Ship-to-Shore, 25 nm
    - » Losing 1350-1850 MHz Band
- **Command Post on the Move**
  - Secure Wireless LAN
    - » Connect Servers Within CP
- **Convoys on the Move**
  - Inter-Vehicle Comms
- **Combat ID**
  - Geolocation
  - Surface Management
    - » Ship-to-Shore Movement: AAV & LCAC
- **Asset Visibility**



# UWB Applications: Comms

**DARPA**

## Urban Warfare

### • MOUT ACTD / USA / USMC

#### - Frustrated Requirements: C4I

- » R1: Identification of Friendly, Enemy, Noncombatants (IFF)
- » R3: Hands-Free Non-Line of Sight (NLOS) Communications
- » R7: Thru-Wall Sensing
- » R41: Position/Location Inside Buildings

#### - Military/Com'l Comms Inadequate

##### » Marine Corps Inter-Squad Radios (ISR)

- ICOM UHF Radios: Non-Secure - 16,000 Units

##### » Need Secure Radio, 1-5 Km Range

- PRC-126 Size, Light Weight (Micro-UAV)
- C2 for Unmanned Ground Vehicles & Video

#### - Transition to Proposed Vanguard ATD '03

#### - Transition to SBCCOM Objective Force Warrior Program



# UWB Applications: Comms

**DARPA**

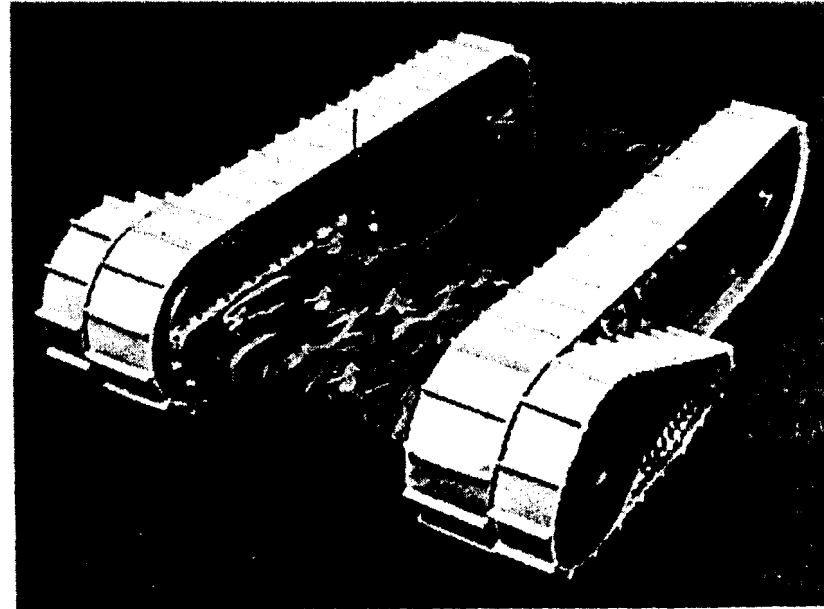
## Tactical Mobile Robots (TMR)

### • Imperatives

- Tele-Operation
  - » C2, Audio and Video
  - » Robots Talk to Each Other
- Geolocation / Navigation
  - » Robots Find Each Other
- Autonomously Reestablish Comms

### • Requirements

- |                                      |   |
|--------------------------------------|---|
| - Bandwidth                          | - Weight & Power: 1-2 lb, 2-5 W                 |
| » C2 & Audio (low latency)   25 Kbps | - Geolocation: 1 cm                             |
| » Video (B&W, fuzzy, min)   100 Kbps | » Navigation/Mapping/Marsupial                  |
| » Color Video (160x120)   1-2 Mbps   | - Environment                                   |
| » High Res Video (320x240)   3 Mbps  | » Urban: Streets, Buildings,<br>Sewers, Tunnels |
| - Range                              | » High EMI: DC Motors                           |
| » 500m min (LAN Block Conv), 1-2 Km  |   |



# UWB Requirements

DARPA

## Advantages

### • Multi-Path

- Minimize Nulls in Urban Environments
- $1/r^2$  --  $1/r^4$  --  $1/r^6$  Losses
  - » 1 - 2 Orders Better than Narrow Band
  - Extra Transmitter Power Not Needed: 10-100X

### • Co-Interference

- FHSS: SINCGARS -- >2.5 Radios Co-located
- DSSS: Near-Far Power Management -- Qualcomm 1 dB Match Required
- UWB: 40-50 dB Rejection

### • Land Mobil Radio (LMR) / Cellular

- Greater Agility: No Critically Tuned Tanks / Combiners / Splitters
- No Dedicated Reservation Channel

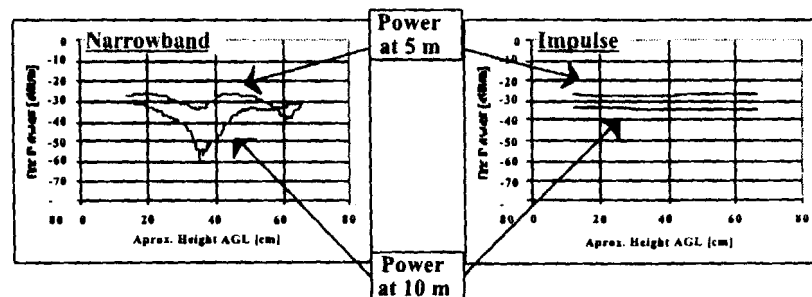
### • Interceptibility

- Inherent LPI/LPD/LPE/AJ

### • Geolocation

- High Inherent Accuracy: Short Pulse Length  $\sim 1$  ns = 1 ft

### • Dual Capability: Communications and Geolocation Simultaneously



# UWB Requirements

**DARPA**

## Architectures

- **Voice**

- Inter Squad Radio (ISR)
- Land Mobile Radio (LMR)

- **Data**

- Burst Store & Forward
- TCP-IP / Packet
- Ad-Hoc Peer-to-Peer Networks

- **Video**

- High Data Rate 1-3 Mbps

- **Geolocation**

- Intra-Squad
- Urban: Bldgs, Streets, Sewers
- Alternate GPS

## Warfighter Requirements

- **Works Anywhere**

- Urban
- Triple Canopy
- Mountain Terrain
- No Terrestrial Infrastructure

- **Quality**

- Fast Enough
- Secure: LPI/LPD/LPE/AJ
- 20 - 30 dB More Link Margin

- **Logistics**

- Small
- Light
- Cheap



# Conclusion

**DARPA**

## Hunter Warrior AWE

- **Marine Corps Warfighting Lab**

- First AWE, 1997      All Data
- RMA: Asymmetrical Warfare

- **DARPA Provided Technology**

- Land Mobil Radio (LMR)
- Internet Node In the Sky (INITS)
- Shared Net: *Content Centric*
- ADOCS / LeatherNet (M&S)
- Surrogates, But They Worked

- **Burst Store & Forward**

- LMR: Serial, 2.7 Kbps
  - » Short Message: OTH Gold & VMF
  - » 3 Sec on Air, Hard to Locate
- INITS: TCP-IP, 300 Kbps Total



"In This World Where We're Carrying **Mobile Handsets**, I'm Afraid the Communications of the World's Most Advanced Military Are Operating at Levels that are 40 Years Out of Date."

Adm. Owens (ret)

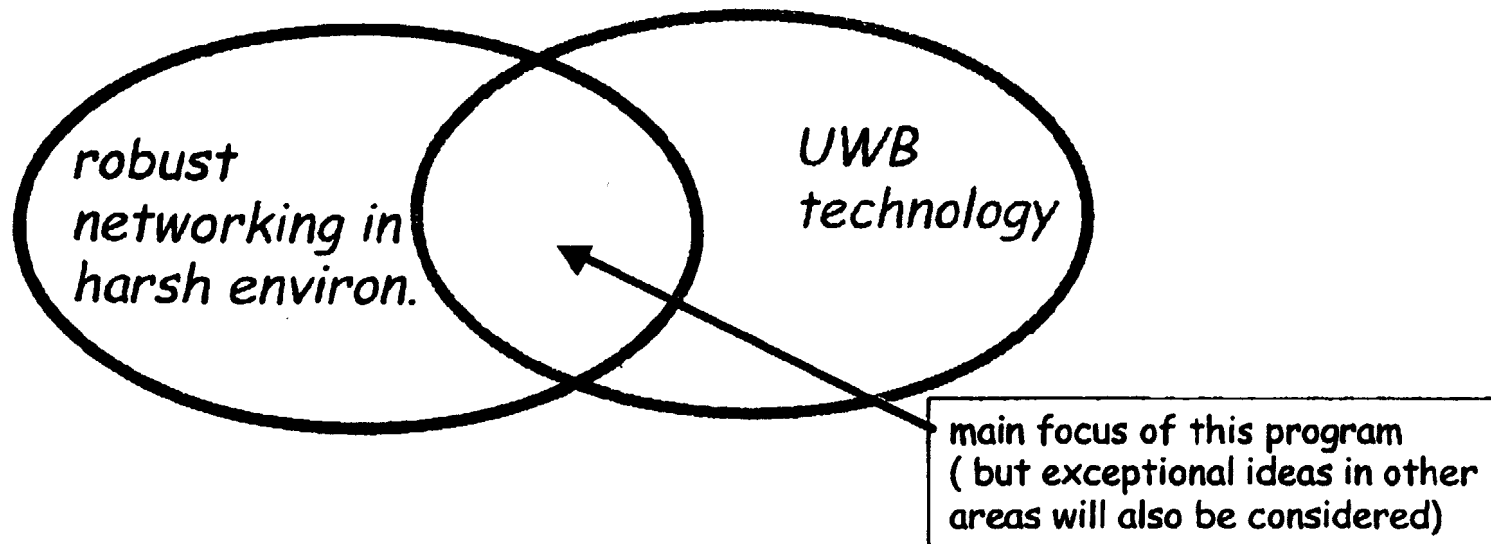
# Networking In the Extreme (NETEX) Program

Industry Day  
Sept 10, 2001

Mari Maeda  
Program Manager  
Information Technology Office  
DARPA

# Program Goal

Robust and rapid wireless networking in complex,  
hostile environments using *UWB* technology



- robust - immunity to fading/outages
- complex - harsh settings, urban, indoor
- hostile - low probability of jam/detect
- rapid - on-the-fly networks, no spectrum assignment

# Why Harsh Environments

- Dense urban terrain represents the single most hazardous setting for engagement
- Casualty rate extremely high
- Increasing shift of world population to cities  
85% of world population by 2024
- GPS often ineffective
- Need to protect our forces, remove personnel from areas of high threat, deploy sensors & robots
- Other harsh settings: on ships, inside cargo containers, close to the ground...

## UWB Claims

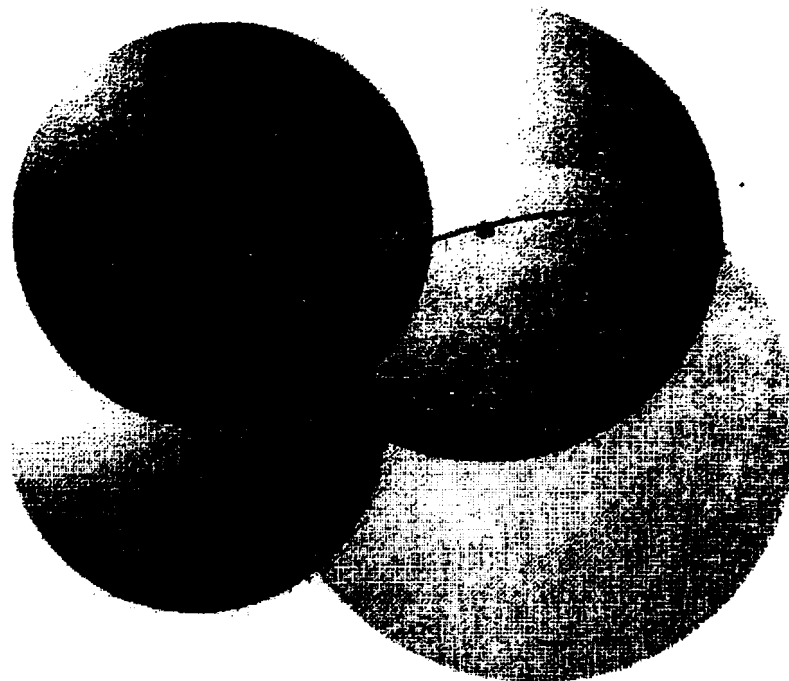
- No fading from destructive interference  
(coherent effects are less)
- Potential for single chip, all digital  
(cost savings)
- Lower power dissipation  
(few analog components)
- Built-in LPI/LPD/LPJ
- No need to get spectral allocation  
(uwb signal is buried in the noise)
- Penetration capability - walls, ground  
(enabled by low frequency component)
- High precision ranging  
(enabled by high frequency component)

- Focus on the real advantages of UWB
- Design and implement next-generation UWB hardware and software for ad-hoc networking in extreme environments.
- Develop uwb network-based geolocalization system
- Demonstrate key DOD applications in appropriately harsh, environments

# Technical Areas

## Precision Geo-Localization

- 3-D multi-lateration
- scalable and power-efficient geolocalization techniques
- in-depth tradeoff analysis  
(accuracy vs.  
power, number of nodes ..)
- mobility support





# **Ultrawideband (Impulse Radio) Communications Technical Challenges**

**NETEX Industry Day**

**10 September 01**

**Dr. James A. Freebersyser  
Program Manager, DARPA/ATO  
(703) 696-2296  
jfree@darpa.mil**





# Potential Advantages of UWB



- **Ultrawideband Operation ( $> 1$  GHz)**
  - Better multipath fading performance (like any wideband signal would)
  - Large processing gain ( $> 40$  dB) improves Anti-Jam (AJ) properties
  - Covert operation (Low Probability of Intercept/Detection (LPI/D))
  - Position location on the order of a few centimeters
- **Greatly Reduced Power Consumption**
  - Single chip (CMOS) implementation without mixed signal processing
  - Low duty cycle operation
  - Higher energy efficiency due to pulsed battery operation
- **More Efficient Use of the Spectrum**
  - More users per unit of bandwidth
  - Unregulated (FCC Part 15) operation
  - Reduced near-far interference resulting from low duty cycle operation
  - Full-duplex operation in the same frequency band

**The Potential of UWB Impulse Radio Has Not Been Realized**



# Summary/Conclusion



- **Ultrawideband - What's Old Is New Again!**
  - Wireless could have gone straight to UWB if DSP had been available ☺
- **A Cornucopia of Commercial and Military Applications**
  - Communications, radar, geolocation, automation, measurement, etc.
- **UWB Has The Potential for Revolutionary Change**
  - Regulatory changes (FCC Part 15?) are needed
- **UWB Research Has Only Just Begun**
  - Propagation, antennas, circuits, devices, waveforms, signal processing, radio architectures, MAC/network protocols, etc.